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AUGMENTING DISTANCE EDUCATION SKILLS DEVELOPMENT IN PARAMEDIC SCIENCE THROUGH MIXED MEDIA VISUALISATION

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KEYWORDS
3D printing, augmented reality, mixed media learning, paramedic science.

ABSTRACT

This paper presents a learning intervention using mixed media visualisation (3D printing and Augmented Reality simulation) to enhance skills development for paramedic science students studying through distance education. Presented is a research methodology to evaluate the effectiveness of the mixed media visualisation techniques to provide more hands-on skill practice to paramedic science students studying the course at a distance. The context for this study is the skills acquisition and retention, focusing on Laryngoscopy with foreign body removal.

The project stems from a need, identified through course evaluations, for more opportunity for distance students to practice skills (currently, they can only be practiced in a five day hands on residential school). Selected students will be provided with 3D printed instruments and a mobile phone augmented reality simulation application that they can use to practice skills prior to arrival at the residential school. Additional training will also be provided to those students not selected using the tools during the residential school. Outcomes are expected to be an overall improvement in final skill level for all students.

INTRODUCTION

In 2001, Prensky (Prensky, 2001, 2009) foreshadowed the arrival of a generation of students that he dubbed "Digital Natives", born and bred in a world immersed in digital technologies. Prensky argued that young people born after 1980 differed from previous generations not only in the degree to which they used technology but also in more qualitative ways, such as the way they interact with technologies and even the way they think and learn. He called for a radical overhaul of education systems because "Today's students are no longer the people our education system was designed to teach" (Prensky, 2001, p.1).

Other papers have since argued against the use of the term "Digital Native" to describe a generation of students (Bennett & Maton, 2010), but it's clear that new technology and innovation can now be used in the classroom that has never previously existed. Specifically, tools such as 3D printing and Augmented Reality (AR) are becoming available for use commercially and thus able to be incorporated into the classroom.

The use of visualization as positive learning support tools are well documented and accepted (Mayer, 2005). Numerous academic disciplines incorporate a variety of 2D and 3D visualisations and haptic manipulations including medical anatomy, architecture, geography, chemistry and media/game design (Freitas & Neumann, 2009). In addition, training has been improved in areas such as nuclear power plant operations and astronaut training (Dalgarno and Hedberg, 2001). The fundamental question is therefore not whether visualization affects learning but how to take advantage of the various visualization media, lesson sequencing and student reflection so that instructions and learning can be more effective (Kozma, 1991, 1994).

Meta-analytic studies of 2D and 3D visualization show positive improvements in learning outcomes among low and high spatial learners (Höffler, 2010). However, these studies are to date inconsistent (Huk, 2006). While some learners learn better when provided with non-dynamic media affording them the opportunity to build their own mental model, other learners learn better through provided virtual dynamic models or physical haptic manipulation (Hwang & Hu, 2013).

No particular media is necessary for learning, nor is a particular method, however both media and methods of incorporation into a curriculum influence learning by influencing each other. Choices have to be made as media constrains and enables methods and methods take advantage of media capabilities (Kozma, 1991, 1994). Typical studies examine only single media coding of the visualization (Höffler, 2010) but secondary modality or multi-modal instruction is important (Mayer, 2002, 2005; Moreno & Mayer, 1999).

Visualization for teaching and learning is nearly ubiquitous. In many cases, visualizations represent either reality, or an approximation of a physical reality.

The specific context of this exploratory study is an introductory paramedic science class studied by many students at a distance. In this class, learning is considered to be an active process influenced by prerequisites of the learner (Mayer, 2002) and the class requires numerous "hands-on" exercises in learning to learn the skills required to be a paramedic. Yet, for many distance students, these skills cannot be provided until they attend residential school, often at the end of a semester of study in a location remote to the

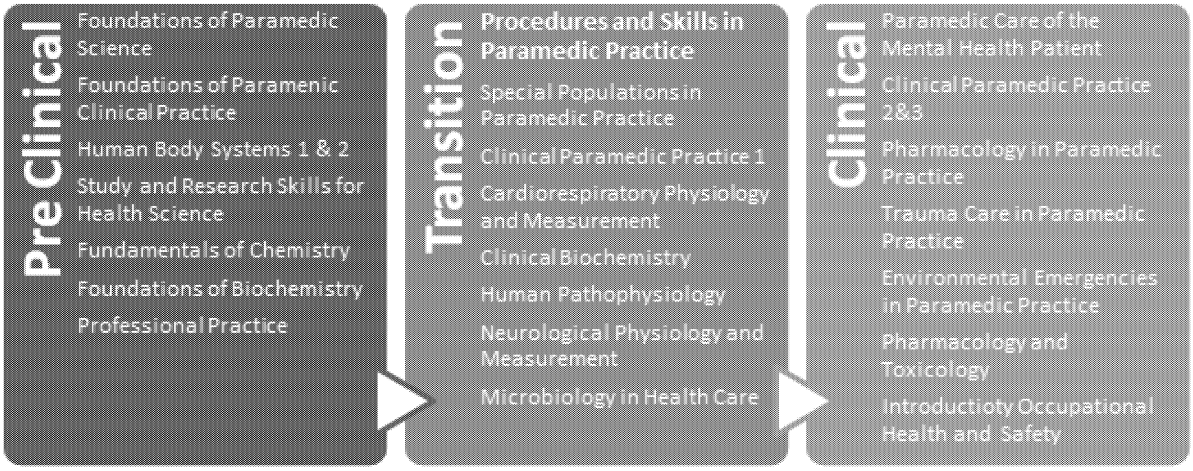

Figure 1: Outline of Paramedic Science Program

university, devoid of the tools needed for skills practice. This type of "hands on" visualization experience is difficult for students studying at a distance.

In this problem domain cutting edge Augmented Reality (AR) could hold the answer as objects can be explored in 3D space but even an object displayed using an augmented reality display can't be touched and held. While haptic technology may hold out the promise of adding the dimension of touch to digital information, this is often difficult for large scale distance education and there is no substitute on the near-term horizon for gaining the knowledge that we gain by holding and manipulating a physical 3D object. 3D printing offers a way to bridge this gap between the virtual and the real (Loy, 2014).

This paper presents an intervention using Mixed Media 3D printing and an AR game to provide a sand box simulation for enhancing skills development for distance paramedic science students and outlines a research methodology to evaluate the effectiveness of 3D printing and augmented reality techniques. This intervention was developed through collaboration of staff from paramedic science, design science and educational technology from two Australian institutions.

BACKGROUND

The CQU Bachelor of Paramedic Science is designed to equip students with the skills to become a Paramedic. They develop foundation knowledge in sciences, human body systems, study and research skills and paramedic practice. The program is three years full time with each year broken down into the following focus areas: Pre Clinical, Transition to Clinical and Clinical (see Figure 1).

As part of this program, one of the first courses looks to develop skills in paramedic science, congruent with the skills required for Queensland Ambulance Service (QAS) paramedics and in line with the QAS procedures. An example is the QAS laryngoscopy procedure and related foreign object removal procedure, as outlined in Figure 2.

In addition, students develop an understanding of paramedic care through investigation of the underpinning theory and practice of procedural applications in the discipline. Knowledge and skills are developed through a series of coursework exercises and practical laboratory sessions as well as a one week residential school for distance students.

Students in the Bachelor of Paramedic Science program are expected to have developed the real world expertise and skills to work as health professionals in emergency medicine and retrieval. Graduates of the program anticipate career options with the government ambulance service, private emergency services or in industry providing paramedic services to mine sites and other areas. Graduates employed in this capacity are eligible for membership with Paramedics Australisia and/or the Australian Registry of Emergency Medical Technicians (AREMT).

Yet despite these very practical requirements, the ability to practice practical skills in the program can be limited for many of the students, who study the program at a distance through a CQUniversity study centre.

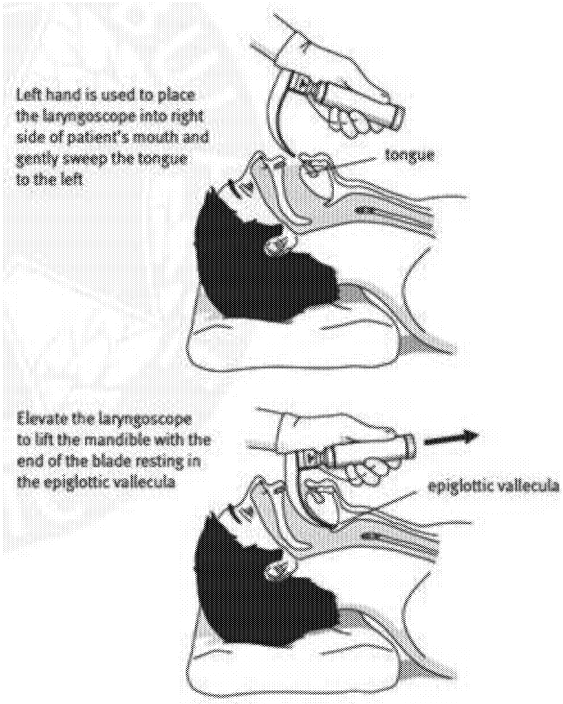

Figure 2: QAS Laryngoscopy Procedure

This is managed to some extent by the program coordinator and course coordinators by intensive residential schools that teach practical skills over the course of a week for various courses, such as the aforementioned skills course, as well as through work integrated clinical courses in the 2nd and 3rd year of the program and the encouragement of students to volunteer for the St John's Ambulance service. However, especially for the second year courses such as the skills development course, more opportunities for practical skill development could be useful for students, and this is discussed further in the next section.

PROBLEM

The CQUniversity paramedic science program seeks to equip students with the practical skills required to be a paramedic, but for distance students the amount of hands on time they have to practice skills can prove challenging. This project stems from a need, identified through course evaluations, for more opportunity for distance students to practice skills (currently, they can only be practiced in the five day residential school). An anonymous sample of the comments made by students in course evaluations is provided in Figure 3 supporting this assertion.

"I believe that because this course is a 'skills' learning course, that there should be a way for us to actually get more time doing skills. I feel that as distance students we are at a severe disadvantage because we spend 5 days doing them in the middle of term and then don't do them again until we hit our placement."

"There is no substitution for experience. Could the school look into either some kind of software or equipment that we could be supplied with so that we can at least go through the motions of doing the skills?"

"I believe that my confidence in performing the procedures and skills could have been improved with a little more 'hands-on' time."

"I feel as an external that I am missing out - they do scenarios every week, I did one or two during res school".

"Studying by distance you can read the skills and kinda do scenarios but it's hard to get feedback and to know if what you're doing is still right."

Figure 3: Examples Student Comments Relating to Hands-On Skills Practice

The proposed intervention seeks to resolve these issues highlighted by students. Selected students will be provided with 3D printed instruments and a mobile application that they can use to practice skills prior to arrival at the residential school. Additional training will also be provided to those students not selected using the tools during the residential school. Outcomes are expected to be an overall improvement in final skill level for all students and immediate attention to the issues raised in the comments in Figure 3. More details on this intervention are provided in the next section.

PURPOSE

The aim of this research is to provide more hands-on skill practice to students, as well as increase overall skill acquisition and retention, focusing on Laryngoscopy with foreign body removal, answering the question "How does the use of 3D printing and augmented reality simulation affect skills development in paramedic science?". The expected outcome of this work is a greater understanding of how 3D printing and augmented reality can assist with skills development and insight into whether these techniques can lead to better learning outcomes.

Whilst previous work has been completed in the field of 3D printing and virtual simulation effect on learner perceptions (for example see Birt and Hovorka (2014)), this project represents a novel combination of the two technologies as a mechanism to test for enhanced skills development. Work in this area will move forward research into the areas of 3D printing and augmented reality for teaching applications and will ultimately benefit the teaching community by providing a greater understanding of how these technologies can be used in classroom practice.

PROPOSED INTERVENTION

Following an action research methodology (Kemmis, 2006), the proposed intervention will involve modifying practice for a subset of students studying the course, creating two learning groups – those with advanced access to the 3D tools and those without. The context of the simulation is a Laryngoscopy procedure with foreign body removal (See Figure 2). To assist in immersion and accuracy a 1:1 scale replication of the actual physical tools is required. In this case we require a 3D printed Laryngoscope with Mac Blade and Magill Forceps (Figure 4). Through the addition of AR markers, these physical models can be tracked and simulated in the virtual game environment (Figure 5).

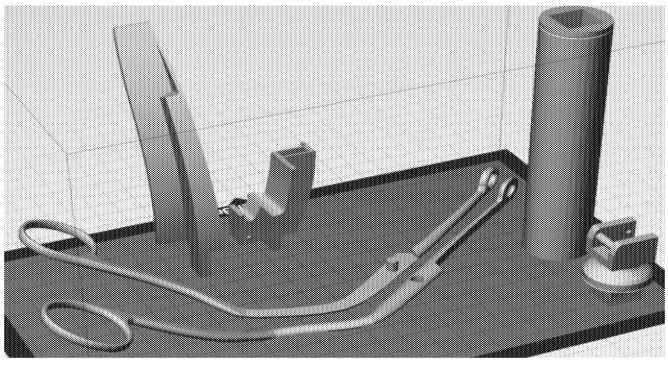

Figure 4: 3D Models representing Forceps and Laryngoscope.

For the augmented reality game simulation the decision was made to use the game engine development platform Unity 3D, (Unity Technologies, San Francisco, CA) and Vuforia AR plugin for Unity 3D (Qualcomm Technologies, Inc). This software is primarily designed for working with object-oriented, multimedia game content and provides a rapid means for deployment to multiple operating systems and mobile device platforms (Figure 6).

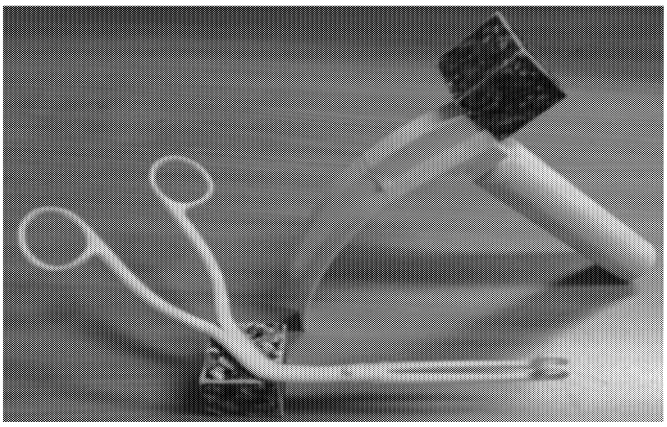

Figure 5: 3D Printed Forceps and Laryngoscope with AR Markers

To allow for the correct view point (looking down the throat of the airway manikin) and keeping the hands free (to use the printed tools with 3D augmented markers) the decision was made to design a 3D printed universal smartphone mount that could be attached to a hat the student wears (Figure 7).

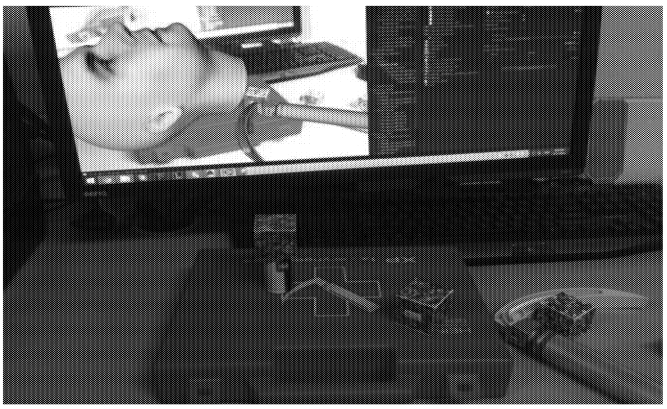

Figure 6: Example of 3D Simulation Objects Visualised in Unity3D with Vuforia Augmented Reality Plugin

The focus of the simulation to be "task appropriate" means only pertinent information relating to the key learning outcomes be included. To this end an audio cue is presented to the user asking them to present the AR tracking markers to the device camera. When all markers have been identified the virtual objects are then intantiated over the camera view of the actual physical tools indicating to the user that the simulation has recognised the markers. An airways maninkin dummy is displayed and a series of steps with audio and visual cues is presented to the user. The aim of the simulation is to follow the steps required to insert the Laryngoscope correctly and then the forceps to remove a foreign body lodged in the patients throat, with cues provided during the simulation to indicate whether the procedure (game) has been successful.

The 3D printed Laryngoscope, Magill Forceps and Phone mount will be provided to Distance Students ahead of the residential school along with the smartphone application. Students will then use the game and printed items to practice foreign object removal on a virtual 3D patient during semester. The game will help students develop correct technique through visual and auditory feedback as the procedure is completed.

RESEARCH METHOD

A stratified sample of 30 students (out of an approximately 120 student cohort) will be selected from the Term 1 2015 cohort to receive the 3D printed instruments (see Figure 5) and access to the augmented reality application (see Figure 7). These students will be given instructions on how to use the tools and will be encouraged to practice prior to the residential school scheduled for late in the term. When students arrive, a pre-test will be conducted with all students to assess skill competency prior to the residential school and to assess the difference between selected students and other students. The traditional "hands on" training will then be provided to all students in the residential school, with an intermediate skills test conducted after this training. Finally, students not selected for the trial will be given extra training using the 3D printed tools and augmented reality application. A final post test will then be conducted with all students and a survey issued to assess how they felt about the intervention methods and use of the tools.

Research data collected will be based on the skills assessment of the students as well as their responses to the survey administered at the end of the skils testing after the residential school. Time commitment from participants will be determined by the students, with the time commitment during the residential school remaining the same as in previous offerings and the only additional time commitment being the time students spent at home using the tools prior to attending the residential school.

Data collected from the skills test will be analysed using SPSS to determine correlations and cross-tabulations between the two groups. Data from the surveys will be analysed using a combination of SPSS for the closed questions and NVIVO for the open questions, with the SPSS data providing correlations between student answers and demographic data, whilst the NVIVO data allows for coding and categoristation and identification of key themes for further research.

Figure 7: Mounted Mobile Phone with 3D Simulation

EXPECTED RESULTS

It is expected that students using the 3D printed objects and simulation game application will perform better on the pre-test, with the selected students requiring less "time on task" teaching at the residential school. More generally, it is expected that there will be an overall improvement for all students in the post-test for final skills level.

CONCLUSION

This paper has presented a proposed intervention and research design to assess the applicability of 3D printing and an augmented reality game simulation to improve skills development for students studying paramedic science at a distance. Through the use of these interventions, it is theorised that students will have more time on task and therefore perform better with their skill development.

Through the use of an action research paradigm, several tests will be performed at various stages to assess this assertion and student skill levels in performng the task that has been simulated. In addition, a survey will be conducted to assess student attitude towards the intervention methods.

Future work will report on the results of this study and provide correlations of various factors related to student performance, showing whether the use of these interventions have improved skills development and whether the tools were accepted by the student cohort. Through this work, a greater understanding of the use of innovate technology tools and games simulation in the education space will be obtained, providing a foundation for future work in the area.

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BIOGRAPHIES

MICHAEL COWLING PhD, MBA, EdD(c) is an information technologist with a keen interest in educational technology and technology ubiquity in the digital age, especially as it relates to International students and those from non-English speaking backgrounds. He is currently a Senior Lecturer in the School of Engineering & Technology at CQUniversity Australia. Dr Cowling is the recipient of 3 CQUniversity Learning and Teaching grants related to teaching technology and was a 2007 recipient of the CQUniversity Award for Excellence in Learning & Teaching (International Campuses). He is also a regular contributor in Australian radio and print media on the topic of Educational Technology and Technology Ubiquity.

EMMA MOORE is a lecturer in the School of Medical and Applied Sciences at CQUniversity. She has come to the University from industry were she has been working as an Advanced Care Paramedic (Level Two) for almost 9 years. Emergency Medicine has always been apart of Emmas life with both her Father and Grandfather working for the Ambulance Service as Paramedics as well. She teaches into the skills development courses of the Bachelor of Paramedic Science. Her research interests are in improving skills development for distance paramedic science students.

JAMES BIRT, B.I.T. (Hons), Ph.D., is an Assistant Professor of Computer games and Multimedia in the Faculty of Society and Design at Bond University Gold Coast, Queensland, Australia. In 2014 James was awarded the prestigious Australian Office of Learning and Teaching citation for outstanding contribution to student learning for his work on improving student learning and engagement through practical juxtaposition of art and science in multimedia education. His research interests are in the areas of mixed media visualization and education technology.